

# **Walkover Radiological Survey Report**

**Fort McClellan  
Calhoun County, Alabama**

**Prepared for:**

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IT Project No. 796887**

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## 1.0 Introduction

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IT conducted an airborne radiological survey in October 2001, over selected areas on the Main Post and Pelham Range at Fort McClellan in Calhoun County, Alabama. The survey used an array of detectors to measure the gamma emitting radioactive materials in the soil. During the airborne survey, several areas of elevated radioactivity (i.e., anomalies), shown on Figures 1 and 2, were identified at Pelham Range. Two of the identified anomalies (P1 and P2 on Figure 1, Rideout Field) were a radioactive waste disposal site undergoing remediation. This site contained cesium 137 (Cs-137) and cobalt 60 (Co-60) sources that had been used in training exercises. Remediation of this area has since been completed and the remediation contractor performed a final status survey. However, radiation "shine" from the uncovered waste masked the area surrounding the remediation site so that it could not be properly characterized during the airborne survey. The area included in the final status survey at Rideout Field is also shown in Figure 1. The other Pelham Range anomalies (P3 through P10) are areas where the elevated counts could not be definitely attributable to naturally occurring radioactive materials. Two anomalies were identified at the Main Post (M1 and M2) and one of these has subsequently been investigated (M1). The anomalies at the Main Post are shown on Figure 3.

IT conducted further investigations on August 26 through 29, 2002, to complete the survey of the area surrounding the Rideout Field anomalies and to determine the nature of the radiological anomalies at Pelham Range and the one on the Main Post. The methods used to complete these investigations and the results are presented in the following sections.

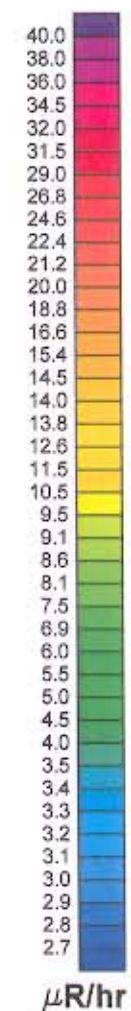
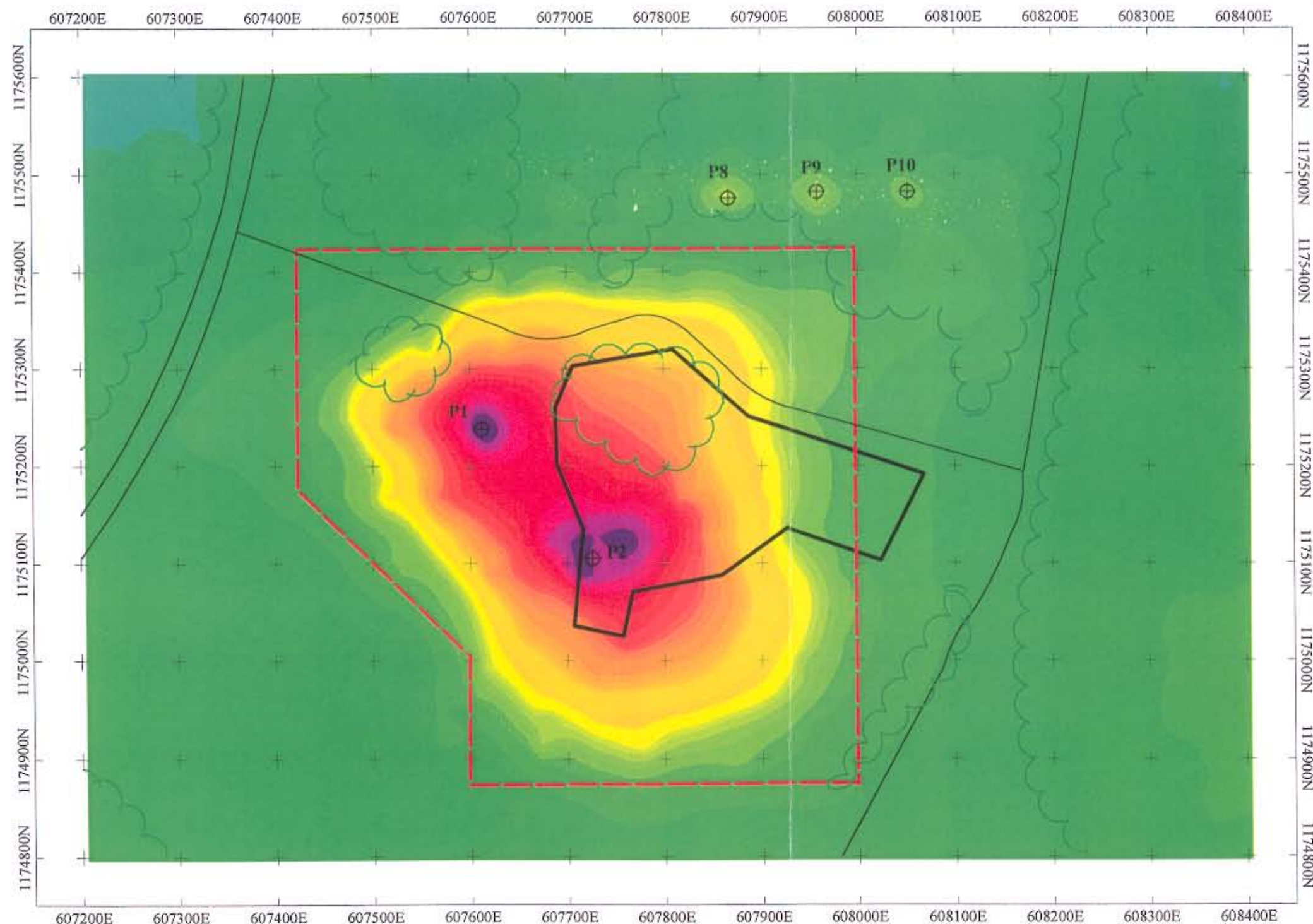
## 2.0 Completion of Radiological Survey at Rideout Field

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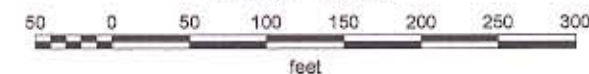
This section describes the survey area and the field procedures and instruments used to complete the radiological investigation at Rideout Field, including survey area and control, data acquisition, and field verification of radiological anomalies identified during the course of this survey.

### 2.1 Survey Area

One area that contained anomalies (P1 and P2) identified during the airborne survey was a radioactive waste disposal site that was undergoing remediation (Rideout Field). The remediation contractor has since completed remediation and has performed a final status survey



Scale 1:1500



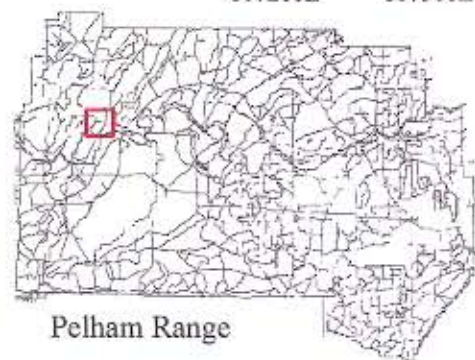
**FIGURE 1**

**RIDEOUT FIELD ANOMALY  
PELHAM RANGE  
FORT McCLELLAN**

AIRBORNE TOTAL EXPOSURE RATE DATA

U.S. ARMY CORPS OF ENGINEERS  
MOBILE DISTRICT  
FORT McCLELLAN  
CALHOUN COUNTY, ALABAMA  
Contract No. DACA21-96-D-0018

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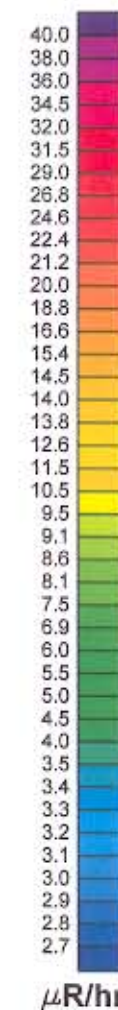
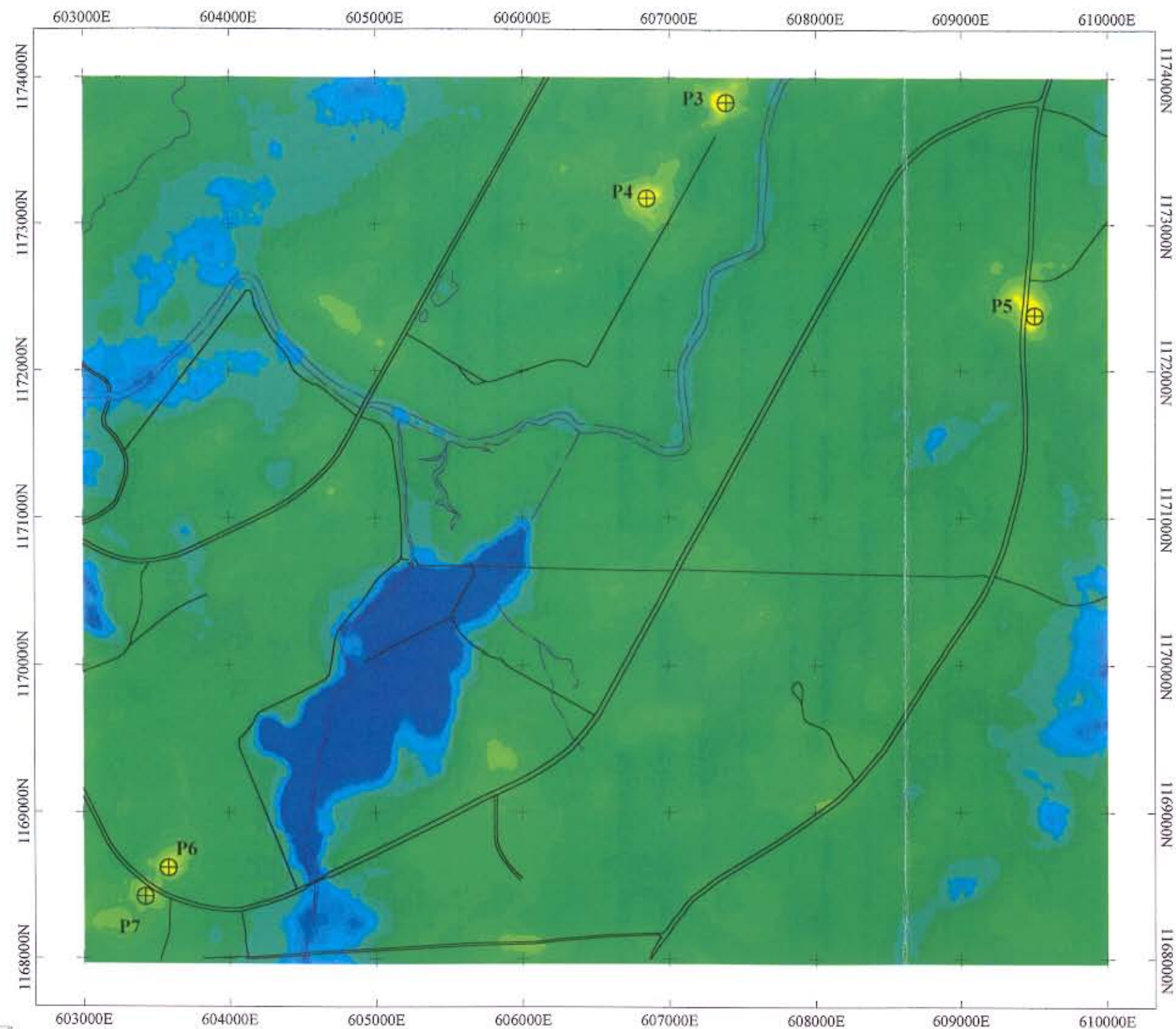


**LEGEND**

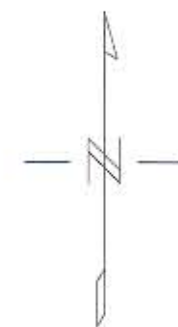
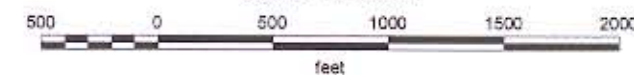
- ATG Final Status Survey Boundary determined from surveyed ATG stake locations
- - - Gridded Survey Area
- Road
- ~ Treeline
- ⊕ Follow-up Survey Location

Note: The survey area is approximately 240650 sq. ft.  
This does not include previous survey area as documented by ATG.  
Coordinate System is NAD83, Alabama East State Plane.





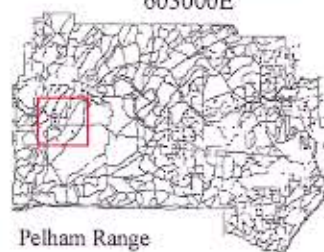
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# **LEGEND**

- ⊕ Follow-up Survey Location
- Road
- River

Note: Coordinate System is NAD83, Alabama East State Plane.



**FIGURE 2**

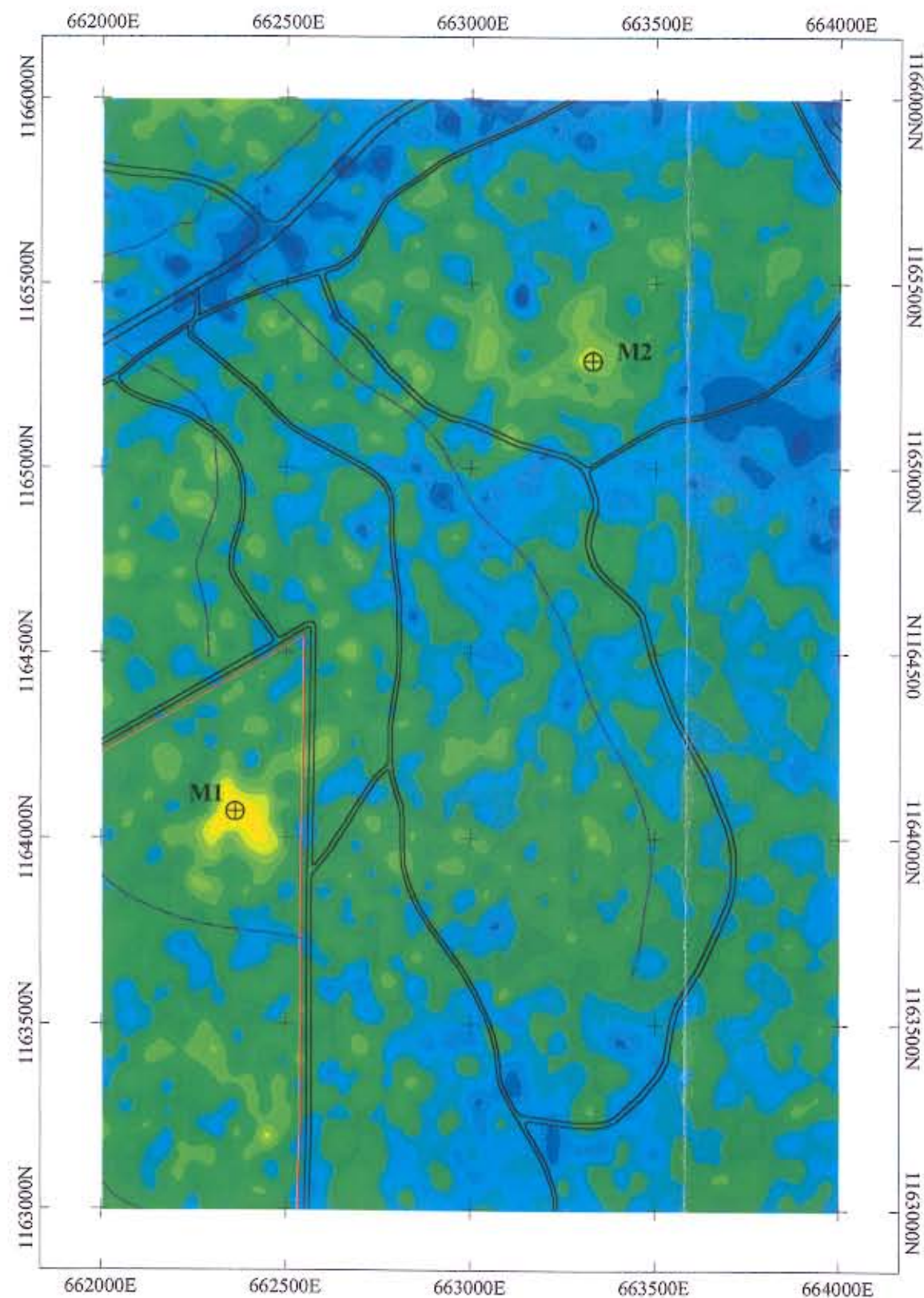
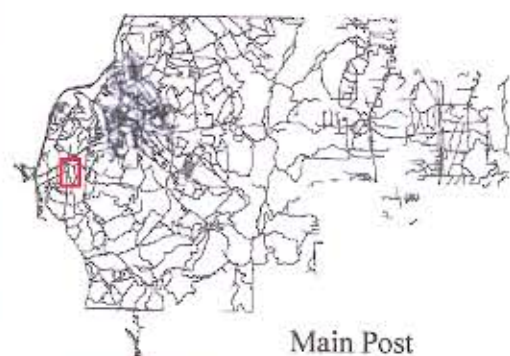
**PELHAM RANGE ANOMALIES  
PELHAM RANGE  
FORT McCLELLAN**

AIRBORNE TOTAL EXPOSURE RATE DATA

U.S. ARMY CORPS OF ENGINEERS  
MOBILE DISTRICT  
FORT McCLELLAN  
CALHOUN COUNTY, ALABAMA  
Contract No. DACA21-96-D-0018

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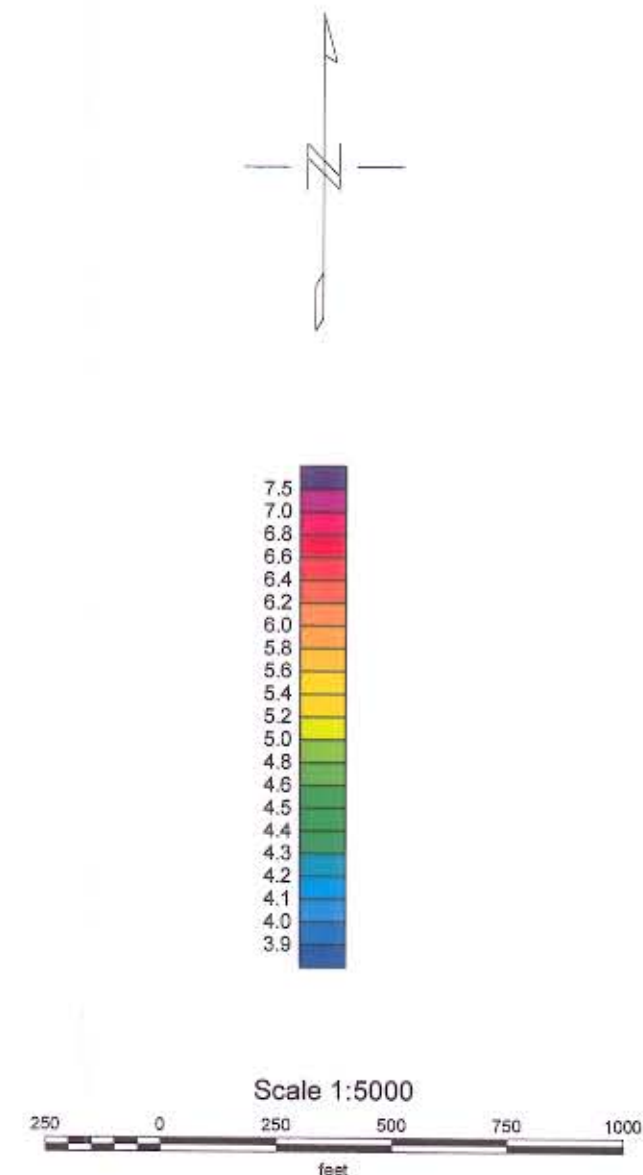




#### LEGEND

- ⊕ Follow-up Survey Location
- Road
- River
- Main Post Boundary

Note: Coordinate System is NAD83, Alabama East State Plane.



#### FIGURE 3

##### MAIN POST ANOMALIES MAIN POST FORT McCLELLAN

AIRBORNE LOW ENERGY/ HIGH ENERGY RATIO DATA

U.S. ARMY CORPS OF ENGINEERS  
MOBILE DISTRICT  
FORT McCLELLAN  
CALHOUN COUNTY, ALABAMA  
Contract No. DACA21-96-D-0018

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1 to document that the site should be released from radiological controls. When the final status  
2 survey boundary is superimposed on the airborne survey map (Figure 1), it can be seen that the  
3 area containing the apparent anomalies is larger than the area remediated and included in the  
4 final status survey. This is expected due to "shine" from the radioactive sources uncovered  
5 during remediation of the site. In order to complete the radiological characterization of Rideout  
6 Field, a survey was performed outside the final status survey boundary and extending beyond the  
7 area affected by shine from the radioactive sources. The survey area is also shown on Figure 1.  
8

## 9 **2.2 Survey Control**

10 Prior to conducting the radiological survey, the boundary of the proposed survey area was  
11 located and marked using caution tape. A Trimble GPS Pathfinder® Pro XR unit was coupled to  
12 the radiological detector during data collection and provided the spatial control required for the  
13 investigation. GPS data were collected using the Alabama East State Plane Coordinate System,  
14 North American Datum 1983 (NAD83). In order to provide reasonable line of sight navigation  
15 during the radiological data collection, marks were made on the ground using surveyor's paint  
16 down the line the surveyor walked during the data collection process. Paint marks were placed  
17 along the outside edge of the Ludlum 2221 rate meter detector swath in order to provide  
18 alignment for the adjacent survey line. A known surveyed location (monitor well) was used to  
19 check GPS accuracy daily.  
20

## 21 **2.3 Radiological Surveys**

22 The radiation detection system used during the investigation consisted of a Ludlum 2221  
23 scaler/ratemeter with a Ludlum 44-10 2" x 2" sodium iodide (NaI) detector sensitive to gamma  
24 radiation. Prior to collecting radiological data, the Ludlum 2221/44-10 instruments were  
25 background and response checked using a known source and the readings recorded in a logbook.  
26

27 The Ludlum 2221/44-10 was then coupled with a Trimble GPS Pathfinder® Pro XR unit so that  
28 the data from the rate meter were logged in real-time by the GPS data logger. The survey was  
29 performed by holding the detector close to the ground surface and swinging the detector in a "S"-  
30 shaped pattern while walking at approximately 0.5 meters per second (m/s). One member of the  
31 survey team followed the operator with surveyor's paint and made marks on the ground to  
32 provide visual indicators of the survey path.  
33

34 Prior to beginning the survey of the Rideout Field anomalies, a reference area (approximately 10  
35 meters by 10 meters) within the boundary of the final status survey was selected and surveyed



1 using the methods described above (see Figure 1). This reference area was selected because of  
2 similar geological makeup to the survey area. In addition, a final status survey has been  
3 completed in this area in support of license termination; therefore, survey results in this area  
4 should represent acceptable radiation levels for Rideout Field. An additional reference area was  
5 surveyed in an unimpacted area at Main Post (Figure 4). This area was selected to provide data  
6 for comparison to surveys conducted at the Main Post where the geological makeup of the soils  
7 is different from the soils at the Rideout Field area of Pelham Range. This reference area was at  
8 the intersection of Diamond Drive and Realm Street.

9  
10 The survey data were collected at 1-second intervals (approximately 0.5- to 1.0- meter (m)  
11 intervals) along roughly north-south (N-S) oriented survey lines spaced approximately 1 meter  
12 apart for most of the survey area. Data were collected in random directions in areas that were  
13 less accessible due to either thick brush or tree cover. The survey data were downloaded to a  
14 laptop computer at midday and at day's end to verify that the data were recorded properly and  
15 that there were no data gaps in the survey coverage. The survey data were backed up on compact  
16 disc (CD) and are retained in project files.

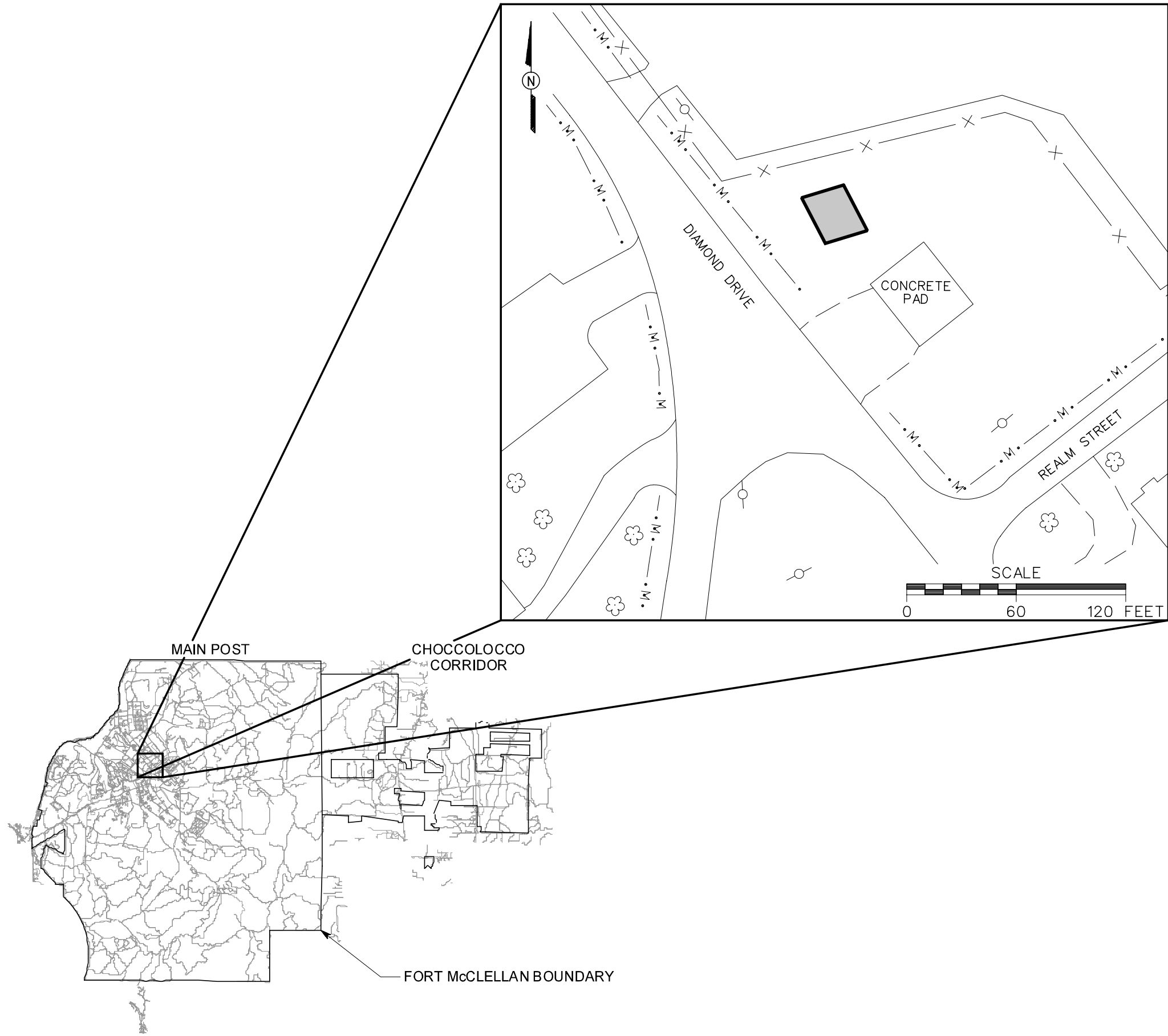
#### 17 18 **2.4 Anomaly Verification**

19 Following the field survey, preliminary color-contour maps of the radiological data were  
20 generated and field-checked. Anomalies caused by topographic features (e.g., gullies) were  
21 labeled as such on the field data maps.

#### 22 23 **2.5 Data Processing**

24 Contour maps of radiological data were generated using OASIS Montaj® data processing and  
25 analysis system from Geosoft, Inc. These maps were color-enhanced to aid with interpreting  
26 subtle anomalies. Select contour maps are presented as Figures 5 through 7.

27  
28 A series of data processing steps were required to generate the contour maps of radiological data.  
29 Initially, field positional and radiological data were downloaded from the TDC1 GPS data logger  
30 to a laptop computer using Trimble Pathfinder® Office. Using Trimble Pathfinder® Office, the  
31 data were exported in an ASCII-format. GPS base station data provided by Intergraph  
32 Corporation were used to differentially correct the positional data. Preliminary data processing  
33 included assessing the ASCII-format data files for correct line and station ranges, removing  
34 unwanted characters and incomplete data records, and assessing overall data quality. Data file  
35 names were recorded on data file tracking forms.

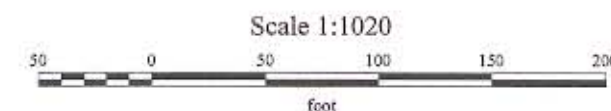
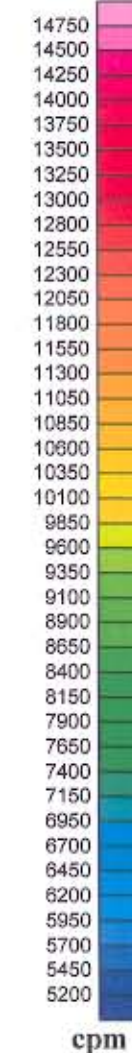
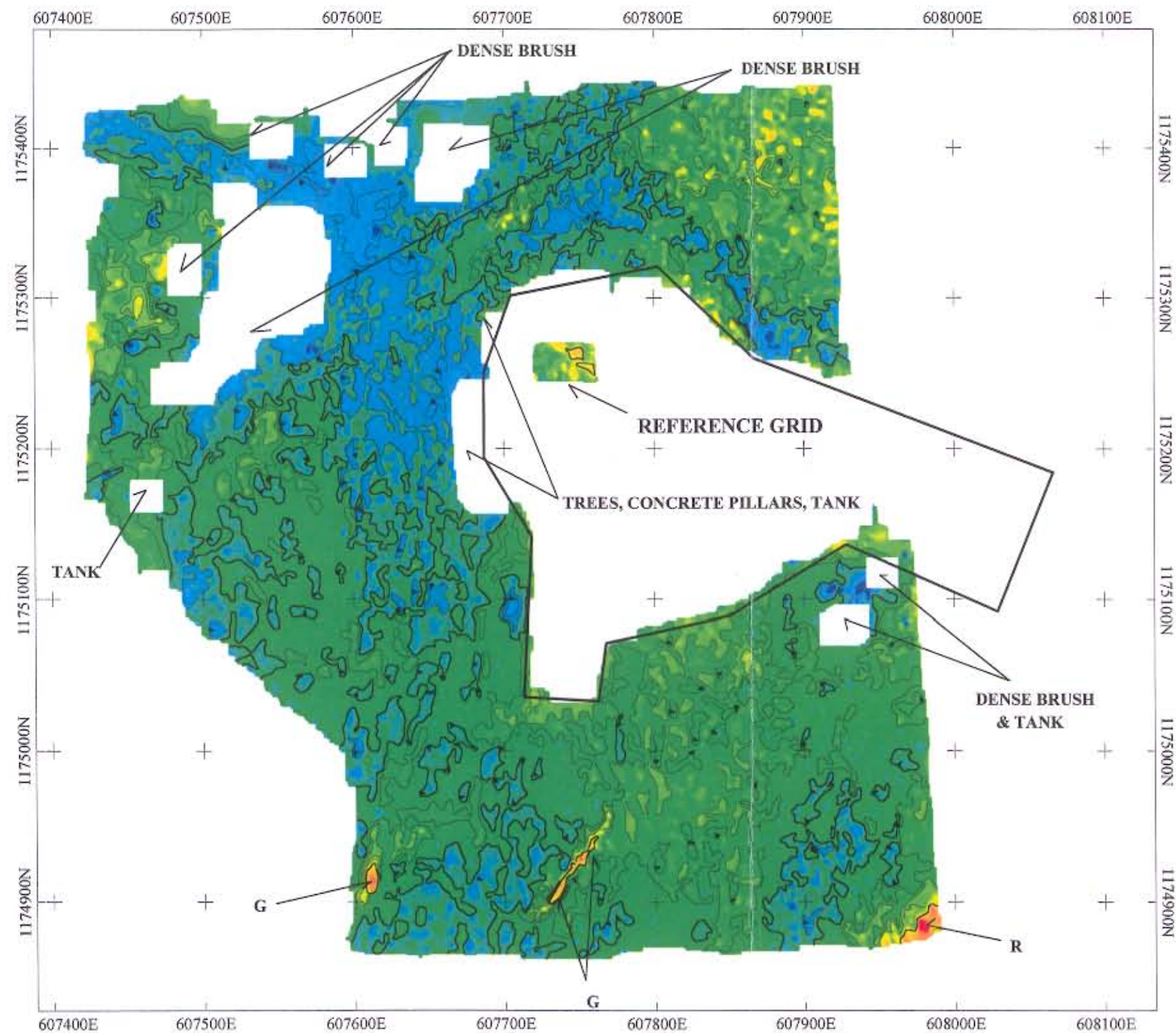


LEGEND

- UNIMPROVED ROADS AND PARKING
- PAVED ROADS AND PARKING
- CONCRETE PAD
- TREES
- REFERENCE AREA
- MANMADE SURFACE DRAINAGE FEATURE
- FENCE
- UTILITY POLE

FIGURE 4  
MAIN POST REFERENCE AREA

U. S. ARMY CORPS OF ENGINEERS  
MOBILE DISTRICT  
FORT McCLELLAN  
CALHOUN COUNTY, ALABAMA  
Contract No. DACA21-96-D-0018



MINIMUM CONTOUR INTERVAL: 500 counts per minute  
 NOTE: Coordinate system is NAD83, Alabama East State Plane

**FIGURE 5**

**RIDEOUT FIELD RADIOLOGICAL SURVEY  
 PELHAM RANGE  
 FORT McCLELLAN**

TOTAL COUNT MAP

U.S. ARMY CORPS OF ENGINEERS  
 MOBILE DISTRICT  
 FORT McCLELLAN  
 CALHOUN COUNTY, ALABAMA  
 Contract No. DACA21-96-D-0018

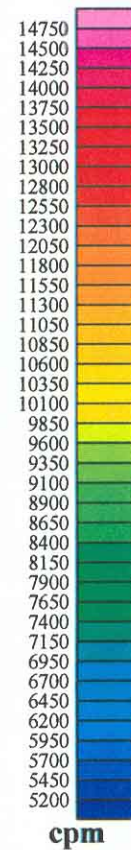
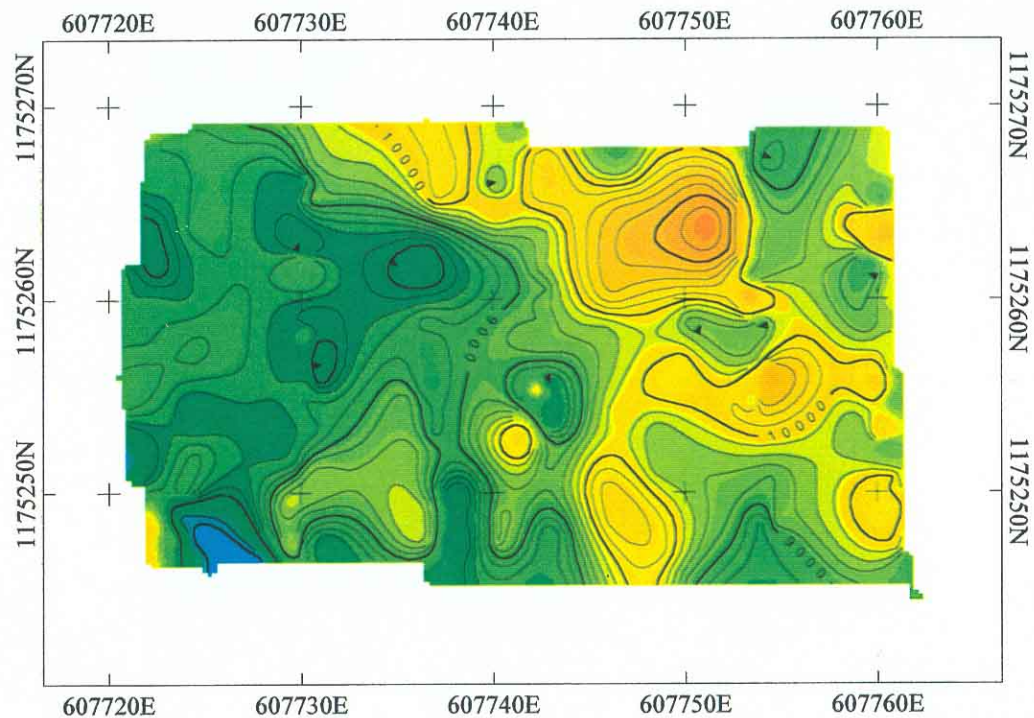


NAME Nicholas Miloski	DATE September 11, 2001
PROJECT NUMBER 796887	LOCATION c:\ITprojects\time\modified.map

**LEGEND**

- R  
G
- ATG Final Status Survey Boundary  
 Anomaly caused by a gravel road  
 Anomaly caused by a gully





Scale 1:120



MINIMUM CONTOUR INTERVAL: 200 counts per minute

FIGURE 6

**RIDEOUT FIELD RADIOLOGICAL SURVEY  
PELHAM RANGE (Reference Grid)  
FORT McCLELLAN**

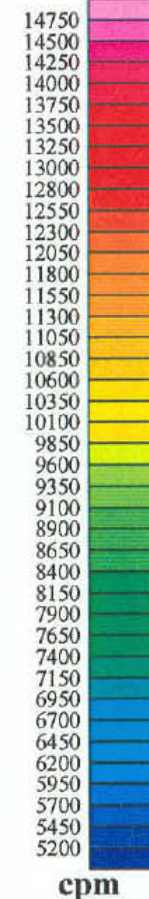
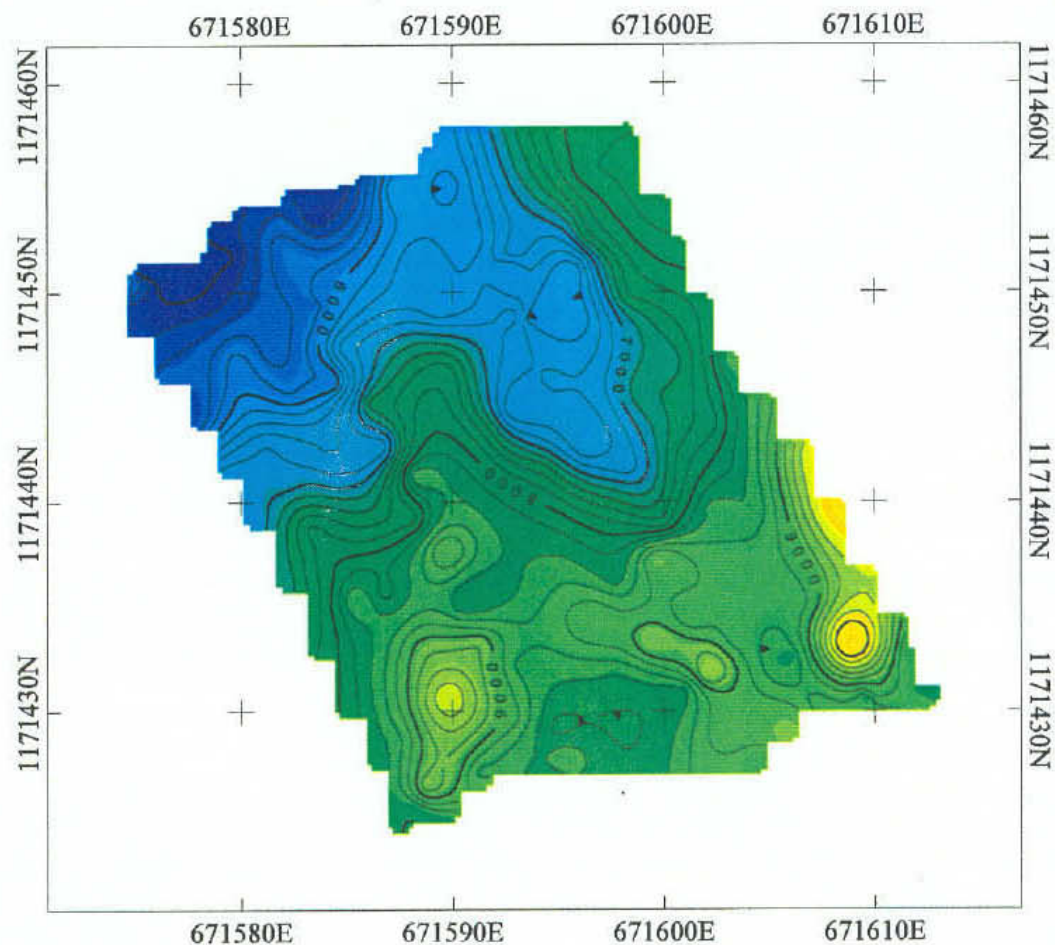
TOTAL COUNT MAP

U.S. ARMY CORPS OF ENGINEERS  
MOBILE DISTRICT  
FORT McCLELLAN  
CALHOUN COUNTY, ALABAMA  
Contract No. DACA21-96-D-0018

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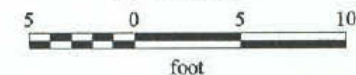
NAME: Nicholas Muloshi	DATE: September 11, 2001
PROJECT NUMBER 796887	LOCATION: c:\projects\time\pelhamRF.map

Note: Coordinate system is NAD83, Alabama East State Plane



cpm

Scale 1:120



MINIMUM CONTOUR INTERVAL: 200 counts per minute

**FIGURE 7**

**RADIOLOGICAL SURVEY  
MAIN POST (Reference Grid)  
FORT McCLELLAN**

TOTAL COUNT MAP

U.S. ARMY CORPS OF ENGINEERS  
MOBILE DISTRICT  
FORT McCLELLAN  
CALHOUN COUNTY, ALABAMA  
Contract No. DACA21-96-D-0018

NAME: Nicholas Muloshi	DATE: September 11, 2001
PROJECT NUMBER 796887	LOCATION: c:\ITprojects\ufmc\mainpost_RF.map

Note: Coordinate system is NAD83, Alabama East State Plane

1  
2 Final, edited ASCII-format data files containing Alabama East State Plane, NAD83 coordinates  
3 (X, Y) and the radiological measurement (Z) were converted to OASIS Montaj® format and  
4 imported into the data processing and analysis software. Data in the OASIS Montaj® database  
5 were reviewed in profile form to verify completeness of data editing. Since two detectors were  
6 used for surveying, the count rates were adjusted to a common base level. This correction was  
7 determined from the source check and reference grid data. The data were then gridded with the  
8 minimum curvature gridding module using an Akima spline. The grid cell size for the  
9 radiological data was chosen to be 0.30 meters. A color contouring scale was selected to  
10 enhance data anomalies of interest to this investigation. The names of files generated and  
11 processing parameters used were recorded on data processing forms. Final processed map names  
12 are shown in the data processing box found in the lower left corner of each contour map  
13 presented. The processed radiological data and the completed radiological data quality control  
14 forms are retained in project files.

## 15 16 **2.6 Results**

17 Results of the surveys conducted at Rideout Field and the two reference areas are found on  
18 Figures 5 through 7. Results for the survey area are within expected ranges for the type of soil at  
19 Pelham Range. These results are comparable to the results measured for the Rideout Field and  
20 Main Post reference areas. Anomalies identified during the course of this survey can be  
21 attributed to the makeup of the soils and the geometry of the measurement. For example, clay  
22 soils typically have a higher natural radiation background than sandy soils. Surveys performed  
23 in a gully will be higher for a given soil type since the detector is surrounded by the source  
24 material thus allowing more of the gamma rays to interact in the detector resulting in a higher  
25 count rate. These anomalies are identified on Figure 5 as either a gully or gravel road. Blank  
26 spaces on the survey map represent areas that were inaccessible due to obstructions such as  
27 concrete pillars, army tanks, or dense brush. There is no indication that radiological anomalies  
28 exist in these inaccessible areas (i.e., no elevated counts near these areas).

## 29 30 **2.7 Conclusions**

31 The radiological investigation at Rideout Field was completed by performing a walkover survey  
32 using a Ludlum 2221/44-10 gamma scintillation detector. Accessible areas outside the boundary  
33 of the final status survey and extending into the area unaffected by radiation shine from the waste  
34 disposal site were surveyed. Survey results were within the expected range for naturally  
35 occurring radioactive materials in soil. Anomalies identified during the course of the survey



were due to variability in soil types and measurement conditions (i.e., geometry). There is no indication that radiological anomalies were present in inaccessible areas.

### **3.0 Investigation of Radioactive Anomalies**

---

This section describes the selection and location of radioactive anomalies identified from the results of the airborne survey and the methods used for investigation.

#### **3.1 Selection of Radioactive Anomalies**

Radioactive anomalies were identified from the results of the airborne survey at Pelham Range and Main Post. Two of the anomalies at Pelham Range were due to the ongoing remediation of a radioactive waste site during the course of the survey. The remediation contractor has since completed remediation and has performed a final status survey of the affected area. Eight anomalies at Pelham Range (P3 through P10) were selected for further investigation based on elevated exposure rates measured during the airborne survey and on historical land use (see Figures 1 and 2).

Two anomalies at the Main Post (M1 and M2) were selected for further investigation (Figure 3) based on the results of the airborne survey. One of these was selected because of the presence of elevated counts in the Cs-137 region and the other was selected because of an elevated Low-E:High-E ratio. The Low-E:High-E ratio is an analysis tool used to help identify potential locations of man-made radiation since the low-energy portion of the spectrum contains the energy from the man-made sources of interest and the high-energy portion of the spectrum is dominated by natural radiation.

IT investigated the Cs-137 anomaly (M1) on February 1, 2002 using a Ludlum Model 19 microR meter and a Ludlum 2221 with a Ludlum 44-10 NaI detector. Subsequent sampling and gamma spectroscopy analysis confirmed the presence of Cs-137.

#### **3.2 Investigative Method**

The radioactive anomalies on the Main Post and Pelham Range were investigated using an Exploranium Gr-135 Identifier portable gamma spectrometer. The GR-135 is used to search for, locate, and identify gamma-emitting radioactive materials. The instrument contains a 4 cubic inch NaI detector and associated analysis software for identification of radioactive material using the built in gamma-ray library.

1  
2 The GR-135 was stabilized each morning prior to use and again at the end of each day. The  
3 instrument was stabilized by placing it in the docking station that contained a small Cs-137 check  
4 source. Stabilization "fine-tunes" the system by adjusting the internal gain and aligning the  
5 spectrometer with the Cs-137 peak.  
6

7 Reference spectra were collected at the Rideout Field and the Main Post Reference areas (Figures  
8 8 and 9). These spectra were used for comparison to the spectra collected at the Pelham Range  
9 and Main Post anomalies, respectively.  
10

11 Each anomaly was located and staked using the coordinates from the airborne survey. Initially,  
12 the area around each stake was surveyed with a Ludlum 2221/44-10 NaI detector (as described in  
13 Section 2.3) to identify the area in the vicinity of the anomaly with the highest count rate. After  
14 the highest count rate area was identified, the portable gamma spectrometer was used to identify  
15 the radiological contaminants at the location by placing the instrument on the ground and  
16 collecting a spectrum for 30 minutes. The GR-135 was used in the "Identify" mode. In this  
17 mode the instrument collects a spectrum for the preset time and, at the conclusion of the count,  
18 automatically performs spectrum analysis to identify the nuclides in the spectrum based on the  
19 reference library. The spectrum analysis indicates the nuclide type (i.e. Industrial, Special  
20 Nuclear Material, or Medical), isotope, and relative size for each identified nuclide. Each  
21 spectrum collected was stored for download to a PC.  
22

23 In addition to the spectrometer measurements, exposure rate measurements were made at the  
24 ground surface and at 1 meter above ground surface using a microR meter. Gamma spectrometer  
25 and exposure rate readings were also collected within the final status survey reference area and  
26 the Main Post reference area. The gamma spectroscopy measurement locations were marked  
27 with surveyor's paint unless the highest reading was found at the location of the stake.  
28

### 29 **3.3 Data Processing**

30 Spectra collected in the reference areas and at each of the anomalies were downloaded to a PC  
31 using the Exploranium Identiview software. The spectra were also converted to a text file and  
32 imported to an Excel spreadsheet for inspection and graphical presentation of the data. Use of  
33 the Identiview software and Excel enabled the data from the reference areas to be viewed with  
34 the anomalies for direct comparison of the spectra.  
35

Figure 8  
Pelham Range Anomalies and Reference Area  
Pelham Range  
Fort McClellan

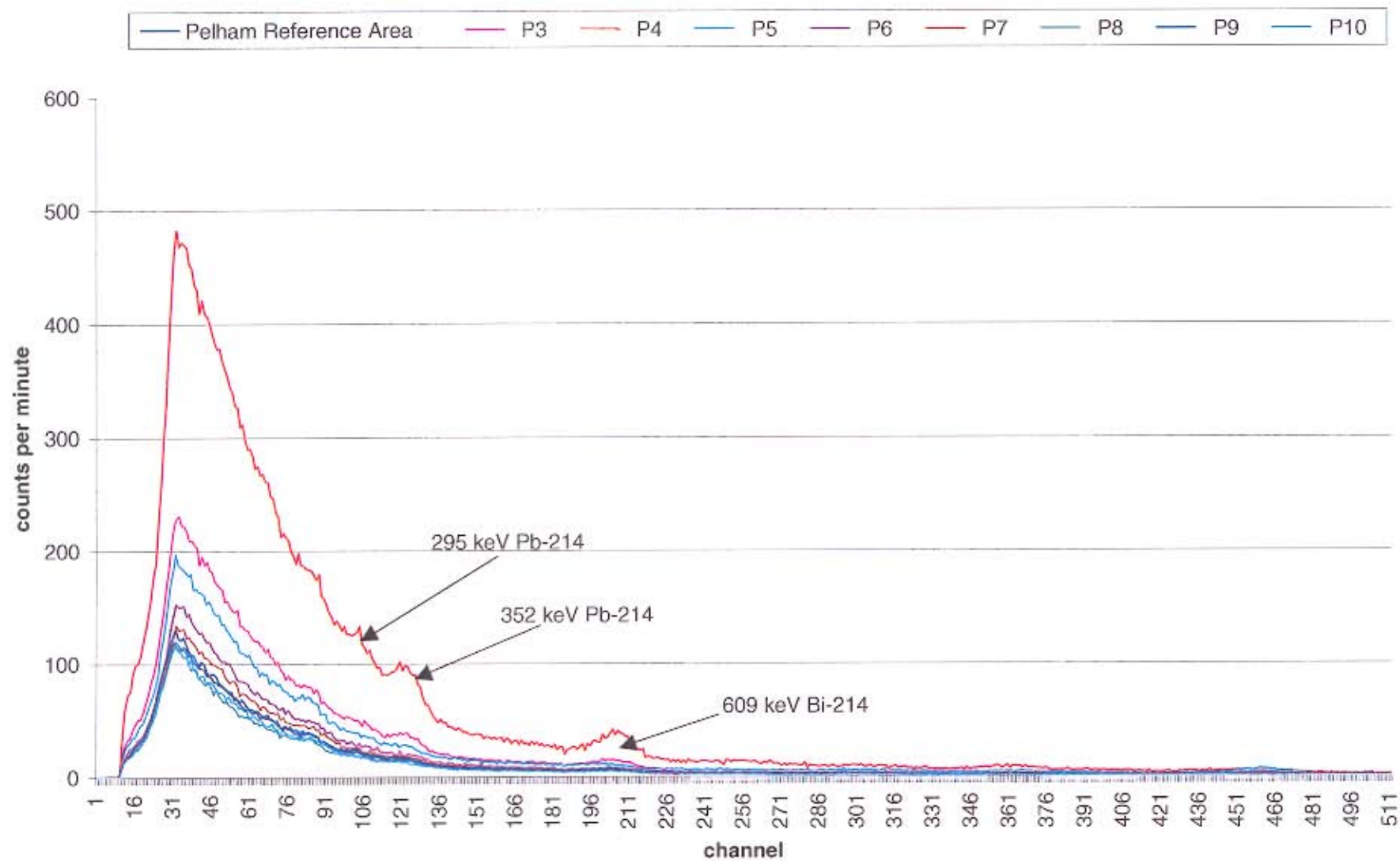
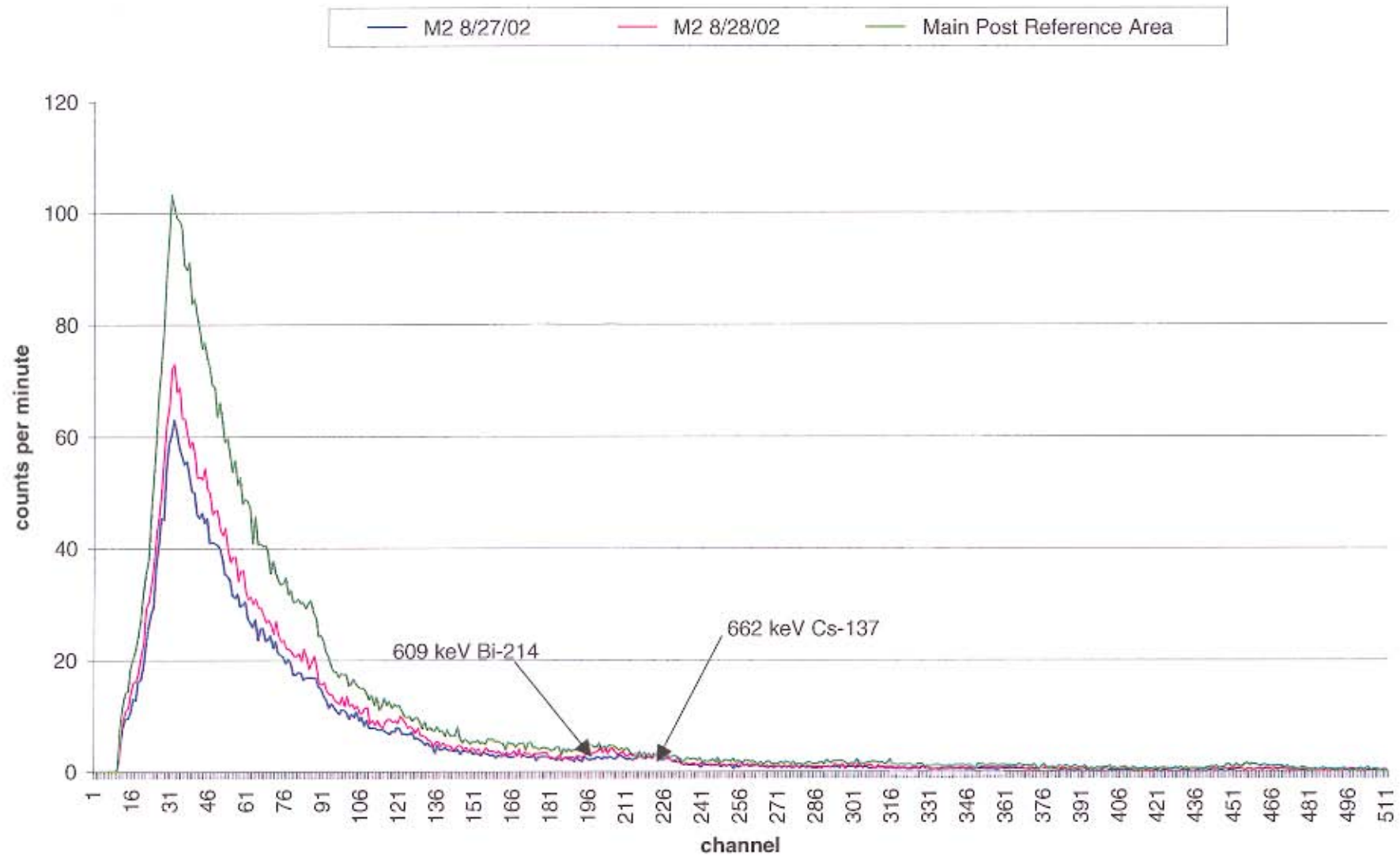




Figure 9  
Main Post Anomaly and Reference Area  
Main Post  
Fort McClellan



### 3.4 Results

Gamma spectra collected at the eight Pelham Range anomalies and the Rideout Field reference area are shown on Figure 8. The only nuclides identified in these spectra were naturally occurring uranium series radionuclides (Pb-214, Bi-214) and potassium 40 (K-40). In some cases, the elevated exposure rates were attributable to visible shale outcroppings or clayey soil. Surface exposure rates ranged from 8 microroentgens per hour ( $\mu\text{R/hr}$ ) for the reference area to 42  $\mu\text{R/hr}$  at Anomaly P4. Relevant comments regarding the Pelham Range anomalies are provided in Table 1.

As mentioned previously, the Main Post Anomaly was selected from the results of the airborne survey because of a high Low-E:High-E ratio. A spectrum was collected at the Main Post Anomaly on August 27. This anomaly is located on a topographic high and had a low exposure rate. No elevated count rate areas were found in the vicinity of the stake that marked the anomaly therefore the measurement was made at the stake. Upon completion of the count, the GR-135 identified Cs-137 in the spectrum. There was some concern that the apparent Cs-137 peak had been misidentified due to thermal drift of the detector (i.e., that the 609 keV Bi-214 peak had been identified as the 662 keV Cs-137 peak). A decision was made to repeat the measurement on August 28 after stabilization of the instrument.

A spectrum was collected at the same location (Main Post Anomaly) during the morning of August 28. No nuclides were identified in this spectrum. A spectrum was also collected at the Main Post Reference Area on August 28.

### 3.5 Conclusions

Eight Pelham Range anomalies were investigated due to elevated exposure rates determined during the airborne survey and based on historical use of the site. The investigations were conducted using an Exploranium GR-135 portable gamma spectrometer. Only naturally occurring radioactive materials (uranium series radionuclides and potassium) were identified in any of these spectra. Elevated count rate areas were associated with clayey soil and visible shale outcroppings. No further radiological investigation of these anomalies is needed.

The Main Post Anomaly (M2) was selected for further investigation due to a high Low-E:High-E ratio. A high ratio for this parameter could be indicative of the presence of man-made radioactive materials such as Cs-137 or Co-60. However, the counts in the Co-60 and Cs-137 channels were low, as was the total exposure rate; therefore, the high Low-E:High-E ratio was probably an

**Table 1**

**Pelham Range Anomalies  
Fort McClellan, Calhoun County, Alabama**

<b>Anomaly Number</b>	<b>Surface Exposure Rate (<math>\mu</math>R/hr)</b>	<b>1-meter Exposure Rate (<math>\mu</math>R/hr)</b>	<b>Comments</b>
P1	8	8	Anomalies P1 and P2 have been remediated. These measurements were made at the Pelham range reference area.
P2	8	8	
P3	17	13	Visible shale outcropping.
P4	42	21	Extensive shale outcropping. Measurement made on shale.
P5	16	12	Shale outcropping. Readings taken in washout gully.
P6	12	10	Kudzu field.
P7	11	9	Clay.
P8	6.5	5.5	
P9	8	7.5	
P10	8	5	

Measurements were made with a Ludlum Model 19 MicroR meter.

$\mu$ R/hr – Microrentgens per hour.



1 artifact due to the low natural exposure rate. A higher natural exposure rate would have  
2 increased the counts in the 609 keV Bi-214 peak and would have masked the low levels of Cs-  
3 137 that are present in soils due to fallout from nuclear weapons testing. Figure 9 shows the  
4 spectrum from the Main Post Reference Area and the two spectra collected at the Main Post  
5 Anomaly M-2. It is concluded that the identification of Cs-137 at the Main Post anomaly was  
6 due to thermal drift of the detector and/or the low natural exposure rate at that location.  
7 Regardless of the reason, it can be seen on Figure 9 that the counts in the overall spectrum are  
8 lower at the anomaly than at the reference area. Therefore, further radiological investigation of  
9 this anomaly is not recommended.